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PATENT SPECIFICATION

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DRAWINGS ATTACHED

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(54) IMPROVEMENTS IN OR RELATING TO FILTERS

(71) We, ZURN INDUSTRIES INC., a Corporation of Erie, State of Pennsylvania, 16512, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to filters for filtering liquids and more particularly to backwash filters and controls therefor where it is desirable to waste a minimum amount of liquid during backwash.

According to the invention there is provided the combination of a backwash filter and a means to control the backwashing of the filter, the filter having a housing with an inlet and an outlet, a filter element within the housing in the flow path of liquid between the inlet and the outlet, a first variable speed motor to move a backwash nozzle mounted on a backwash arm across the surface of the filter element and a positive displacement pump driven by a second variable speed motor for removing liquid through the backwash arm, and the control means comprising means for sensing the differential pressure between the inlet and the outlet, said sensing means being so connected to means for controlling the speeds of the variable speed motors that said pressure sensing means automatically adjusts the speeds of the said motors so as to control the backwashing process to remove debris from the filter element at a rate determined by the rate of deposit of debris on the filter element.

Preferably the filter element has openings therethrough having cavities at the upstream side of the filter element.

The means for sensing the differential pressure may be a tranducer and preferably the control means further comprises tachometers for sensing the speeds of the motors.

Preferably means are provided to control the speed of the displacement pump at a fixed ratio to the speed of the backwash arm and the ratio may be adjustable.

Preferably the filter element has areas thereof which are unperforated, and means may be provided on the filter to deactivate the displacement pump when the backwash nozzle passes over said areas.

A specific embodiment of the invention will now be described by way of example with reference to the accompanying drawings, in which:—

Figure 1 is a longitudinal cross-sectional view of a filter embodying the invention,

Figure 2 is a cross-sectional view of the filter taken on the line 2—2 of Figure 1,

Figure 3 is an enlarged partial view of the filter element,

Figure 4 is a block diagram of the filter and control elements, and

Figure 5 is a schematic diagram of the electrical controls.

The continuously backwashable filter or strainer shown in Figs. 1 and 2 has a hollow body which is made from a generally cylindrical outer shell 10 closed at its top by the cover 26 and closed at its bottom by the plate 27. The plate 27 and ring 28 are welded to the outer shell 10 around the inner periphery thereof in a well-known manner. The cover 26 is supported on ring 28 and is attached to the ring 28 by means of studs 29. The plate 27 has an inlet opening 31 therein which communicates with the inside of the filter element and is connected to an inlet pipe 20. The shell has an outlet opening therein which is connected to a suitably flanged pipe 21 whereby it is connected in a flow line.

The plate 27 has an opening in the center that is connected to the backwash outlet fitting 22. A bearing 32 is fitted into this opening and the bearing 32 receives the lower end of the shaft 35.

The filter element is made up of the hollow cylindrical inner cage 13 and the hollow cylindrical outer cage 11 that sandwich the filter medium 12 therebetween. The inner cage and outer cage have a number of holes 43 and 42 respectively that align with each other as shown in Fig. 3, so that a segment of wire screen straining mesh or filter medium

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12 is exposed in each hole. This will be more completely described hereinafter.

The top of the filter element is supported in the body by means of a ring 37 and the bottom is supported in a ring 38. The ring 38 is L-shaped in cross section and is welded to the plate 27 so that it presents an annular seat 39. The seat 39 receives the ring 40 which is welded to the outer periphery of the inner cage 13. It will be noted that the inner cage 13 is longer than the outer cage 11 and the ends of inner cage 13 extend above and below it. The ring 40 has an O-ring seal therein which forms sealing engagement between the ring 40 and the ring 38.

The outer periphery of the upper end of the inner cage is welded to the ring 37 and the ring 37 has an O-ring 41 in a suitable groove which makes sealing engagement with the inner periphery of the ring 28.

It will be noted that the lower ring 40 is smaller than the upper ring 37 so that the strainer can be readily removed by removing the cover 26 and lifting the entire filter element out.

The holes 43, in which the particulate matter filtered from the fluid is collected, can be about 3/16 inch to about 1/2 inch, preferably about 1/4 inch in diameter. The inner shell 13 of the cage must be of sufficient thickness to provide mechanical integrity and volume for the collection of particulate matter. It is preferred that the ratio of open to closed area in inner cage 13 and outer cage 11 be as large as possible, commensurate with the assurance of structural strength in the drilled cages.

The filter element disclosed herein can be made by the following method to perform the required function. The inner cage is made by providing a hollow cylindrical member which has an outside diameter slightly greater than the desired diameter of the finished inner cage 13. The inner cage is then welded at its lower end to the ring 40 and at its upper end to ring 37 and all surfaces are rough machined to remove scale and weld spatter. The inner cage 13 is then heat treated to relieve all internal stresses. All surfaces of the inner cage 13 are then accurately machined to the proper finished dimension and shape.

A second hollow cylindrical member is then provided to form the outer cage 11 and this hollow cylindrical member is rough machined inside and out to remove scale. The vertical flanges 50, 51, 52, and 53 are then welded in place to the outer hollow cylindrical member and the assembly is stress relieved.

The inner periphery of the outer cage is machined to a finish dimension which is sufficient to give a clearance space between the inner and outer cage sufficient for the mesh filter medium 12. That is, the inside diameter of the outer cage 11 will be an amount greater than the outside diameter of the inner cage 13 equal to twice the approximate thickness of the mesh 12. The outer cage 11 is then split axially between the flanges 50 and 51 and between the flanges 52 and 53 to provide two separate halves of the cage.

The outer periphery of the inner cage 13 is then wrapped with a shim material having a thickness approximately equal to the thickness of the strainer element 12, and the outer cage 11 is placed therearound and bolts 54 and 55 are put in place and tightened. Multiple holes 42 and 43 are then drilled and deburred.

The bolts 54 and 55 are then removed, the shim taken out, and the filter medium 12 assembled between the outer and inner cages. The filter element is assembled by laying the filter mesh over the outside circumference of the inside shell after removing the outer cage, and then putting the outer cage halves carefully over the mesh. Bolts 54 and 55 are then inserted. The filter element is then ready to assemble in the filter body as shown in Figs. 1 and 2.

Experimental work has shown that with a screen having a mesh approximately 100× 100 wires per inch with 0.0065" diameter openings, particles that would be deleterious to other equipment in the system will be filtered out. It has been found that by using a filter mesh much finer than the smallest particles to be removed, the problem of severe blinding and inefficient backwash can be alleviated. Thus, screens with openings of 75 microns or less are found to give unexpected results in efficiency of backwash in the filter disclosed herein.

Although only one backwash arm 15 is shown in Figs. 1 and 2, the backwash tube 35 can be equipped with multiple backwash arms. For example, tube 35 can be provided with two backwash arms 15 mounted at 180 degrees from each other. The tube 35 is attached to a shaft 34 which is supported by a bearing in the speed reducer 17 and driven by the variable speed motor 19 through the speed reducer 17 and the shaft is keyed to the speed reducer by means of a shear pin 18. The vertical and horizontal thrust of the shaft 34 is provided by speed reducer 17.

The lower end of the backwash tube 35 indicated communicates with the backwash outlet 22. Backwash tube 35 has an axial slot 36 at an intermediate position. Slot 36 is connected to the backwash arm 15. The cover 26 has packing in a central opening therein with suitable packing gland 16 through which the shaft 34 of the backwash arm 15 extends. Plate 27 has inserted therein a bearing 32 which supports and seals the lower end of backwash tube 35.

The backwash arm 15 has two axial shoes 25 attached to its outer end. The shoes 25 are spaced from each other and provide a space 44 therebetween. Thus, when the back-

wash arm 15 is swung around its axis, which is coaxial with the central axis of the filter element, the shoes 25 move in close relation to the inside periphery of the inner cage, forming a seal between space 44 and the interior of the straining mesh 12. It has also been discovered in one application that the rotation of the backwash arm can be controlled within a range of two to thirty surface feet per minute for optimum efficiency. The space 44 provides a lower pressure area on the inner periphery of the inner cage to receive particles of material which have been strained out of the liquid on the upstream side of the filter mesh. Since the liquid on the downstream side of the mesh will have a higer pressure than the pressure in the space 44 liquid will flow through the filter element in a reverse direction; that is, from the outside of the mesh to the inside of space 44 and into the backwash arm 15, thereby carrying the material that has been trapped in the holes 43 and on the screen straining mesh into the backwash arm 15 and out through fitting 22 to a metering pump 60.

The shoes 25 operate as close as possible to the inner periphery of the inner cage 13. The clearance between the shoes and the inside of the cage should never exceed one-eighth inch.

The slot defined at 44 in the backwash arm 15 can be, for example, between one-quarter inch wide and two inches wide, but preferably the slot 44 is of a width to cover one vertical row of holes 43. The shoes 25 are preferably wide enough to prevent leakage of the fluid from the interior of the filter element into the backwash arm 15. In order to provide effective sealing, the shoes 25 and bearing 32 can be constructed of a resilient material, for example, polytetrafluoroethylene (Teflon) Registered Trade Mark, polyoxy methylene resin (Delrin) Registered Trade Mark, polyethylene, polypropylene, etc., and can be operated in contact with the inner periphery of the inner surface of the cage 13.

The filter, and controls in combination with it are shown in Fig. 4. The filter has an inlet 20 and outlet 21. The backwash metering device 60 shown is connected to the backwash outlet fitting 22. It may discharge to a drain through a line 61 or it may discharge to some other suitable repository. The backwash metering pump 60, which is a rotary positive displacement pump, is driven by a variable speed motor 62, having a tachometer 63 connected to it, which is connected by the line 64 and 71 to the control cabinet 65. A suitable differential transducer 66 is connected to the outlet 21 through the line 67, to the inlet 20 through the line 93. A variable speed drive motor 19, having a tachometer 80 connected to it, is connected through a line 70 to the control cabinet 65. The transducer 66 is connected through lines 71 and 82 to the control cabinet 65. Tachometer 80 is connected through line 83 to control cabinet 65.

Thus, transducer 66 senses differential pressure across the filter element and causes the speed of drive motor 19 to increase when the pressure difference increases or to decrease when the pressure difference decreases. An adjustable proportional control maintains the speed of the motor 62 at a predetermined relationship to the speed of motor 19.

A method of electrical control is shown in Fig. 5 which schematically illustrates the relationship of the motors, tachometers, limit switches, differential pressure transducers, and control cabinet components. The control cabinet contains a conventional type of control similar to Boston Gear Works Series E control marketed under their trademark "RATIOTROL". Components located in the cabinet 65 consist of two individual motor speed controls 94 and 95 which regulate the speeds of motors 19 and 62 respectively. Tachometer 80 feeds a signal back to the speed control 94 to accurately maintain the selected speed under varying load conditions. Tachometer 63 functions similarly with speed control 95. Both tachometers 80 and 63 may be provided with a meter to visually indicate motor speed.

A master speed control 96 provides the means of simultaneously adjusting the speeds of motors 19 and 62 through their individual speed controls. This adjustment can be made manually by means of a selector mounted on the cabinet or automatically by means of the pressure transducer 66.

Switch 97 controls the main electrical supply. Switches 98 and 99 provide the means of isolating individual speed controls for testing and calibrating purposes. Swith 100 provides a means for isolating the transducer 66 for testing and calibration purposes.

Suitable gauges 72, 73, and 74 are connected by lines 84, 87, and 86 to lines 21, 22, and 20, respectively, as shown to indicate the pressures in these lines. Limit switches 75 and 76 are connected through lines 92 and 81 to the control 65. When the backwash arm 15 with shoes 25 and backwash arm slot 44 passes over the unperforated areas 77 and 78 of the cage, the power to motor 62 will be shut off by limit switches 75 and 76 so that a suction pressure will not be exerted on this unperforated area of the strainer. Such a suction on the unperforated area of the filter element might cause the backwash arm to be held against the inner cage and resist further movement due to the suction created by metering pump 60.

Backwash metering pump 60 will deliver material at a controlled rate. The displacement and the speed of the pump 60 can be so regulated by the controls in cabinet 65 that it will remove an amount of material from the openings 43 approximately equal to the

volume of openings 43 each time the slot 44 moves over these openings. Thus, the transducer 66 can be used to actuate the controls in cabinet 65 when a predetermined variation in pressures is sensed therein. The controls are so actuated that the speed of the backwash metering pump 60, sensed by tachometer 63 and the speed of the backwash arm motor 19, sensed by tachometer 20, will vary as required to maintain flow through the filter while backwashing with the minimum amount of fluid required to remove the accumulated debris. The type of control described can be accomplished by electrical, hydraulic, or pneumatic means.

WHAT WE CLAIM IS:—

1. The combination of a backwash filter and a means to control the backwashing of the filter, the filter having a housing with an inlet and an outlet, a filter element within the housing in the flow path of liquid between the inlet and the outlet, a first variable speed motor to move a backwash nozzle mounted on a backwash arm across the surface of the filter element and a positive displacement pump driven by a second variable speed motor for removing liquid through the backwash arm, and the control means comprising means for sensing the differential pressure between the inlet and the outlet, said sensing means being so connected to means for controlling the speeds of the variable speed motors that said pressure sensing means automatically adjusts the speeds of the said motors so as to control the backwashing process to remove debris from the filter element at a rate determined by the rate of deposit of debris on the filter element.

2. The combination as claimed in claim 1, wherein the filter element has openings therethrough having cavities at the upstream side of the filter element.

3. The combination as claimed in claim 1 or 2, wherein the means for sensing the differential pressure is a transducer, and the control means further comprises tachometers for sensing the speeds of the motors.

4. The combination as claimed in any of the claims 1 to 3, wherein means is provided to control the speed of the displacement pump at a fixed ratio to the speed of the backwash arm and wherein said ratio is adjustable.

5. The combination as claimed in any of claims 1 to 4, wherein the filter element has areas thereof which are unperforated, and wherein means are provided on the filter to deactivate the displacement pump when the backwash nozzle passes over said areas.

6. A backwash filter substantially as hereinbefore described with reference to the accompanying drawings.

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FIG.1

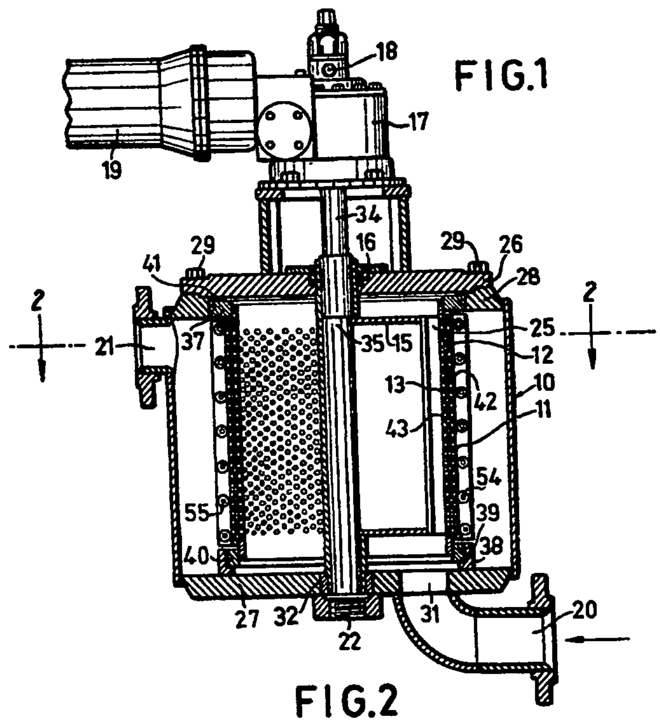
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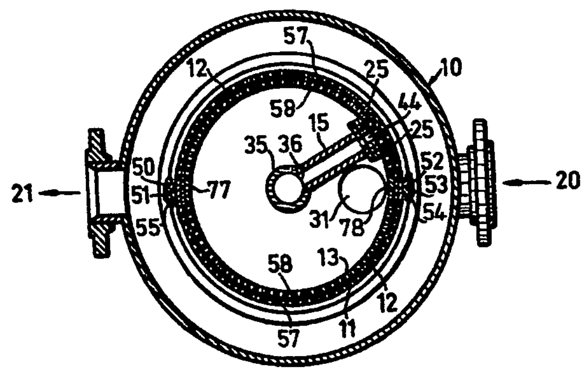
FIG.2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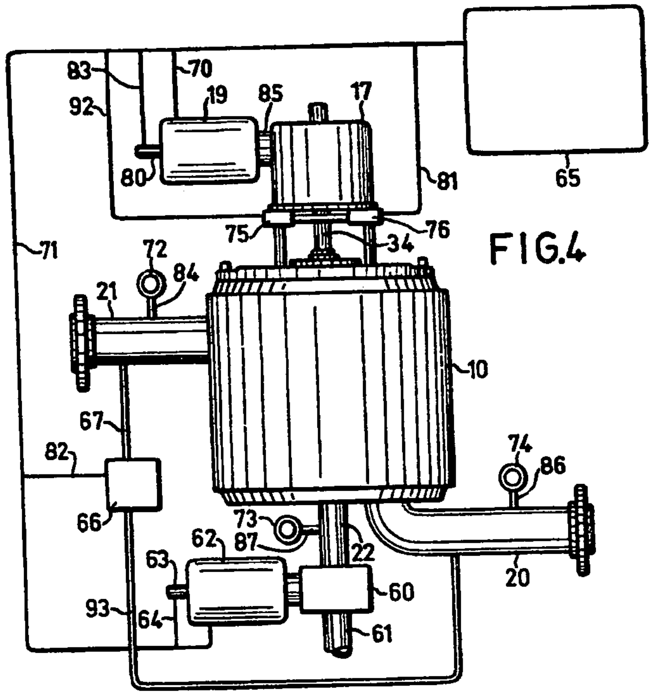

FIG.4

FIG.5

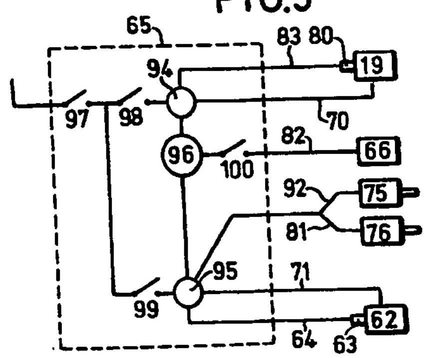

FIG.3